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ABSTRACT

This is the first in a series of three guidebooks on minimum course content for gifted grade seven students who will begin algebra in grade eight. The topics covered include integers, sets, number properties, open sentences, and graphing; concepts are stressed. Overall course goals are specified; a course outline, performance objectives, suggested teaching strategies and text references are listed. A pretest and a posttest are also included. (For the third booklet in the series, see ED 079 132.) (JP)

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AUTHORIZED COURSE OF INSTRUCTION FOR THE QUINMESTER PROGRAM

DADE COUNTY PUBLIC SCHOOLS

PURE MATHEMATICS I

5211.31

MATHEMATICS

SE 017 032

DIVISION OF INSTRUCTION • 1971

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QUINMESTER MATHEMATICS

COURSE OF STUDY

FOR

PURE MATHEMATICS I

5211.31

(EXPERIMENTAL)

Written by
Doris K. Blanford
James E. Thornton, Jr.

for the

DIVISION OF INSTRUCTION
Dade County Public Schools
Miami, Florida 33132
1971-72

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PREFACE

The following course of study has been designed to set a minimum standard for student performance after exposure to the material described and to specify sources which can be the basis for the planning of daily activities by the teacher. There has been no attempt to prescribe teaching strategies; those strategies listed are merely suggestions which have proved successful at some time for some class.

The course sequence is suggested as a guide; an individual teacher should feel free to rearrange the sequence whenever other alternatives seem more desirable. Since the course content represents a minimum, a teacher should feel free to add to the content specified.

Any comments and/or suggestions which will help to improve the existing curriculum will be appreciated. Please direct your remarks to the Consultant for Mathematics.

All courses of study have been edited by a subcommittee of the Mathematics Advisory Committee.

CATALOGUE DESCRIPTION

The first of three quins designed for the mathematically gifted Grade 7 student who will begin algebra in Grade 8. Includes integers, sets, number properties, open sentences, and graphing. The pace will be rapid; concepts will be stressed.

Designed for the highly motivated, mathematically gifted Grade 7 student; thorough knowledge of elementary school mathematics is necessary.

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GOALS

1. To increase student knowledge and awareness of the underlying structure in mathematics.

2. To develop the student's skills in computation with integers.

3. To further develop students' ability to use and understand set notation.

4. To introduce students to graphing on a plane.

KEY TO REFERENCES

(* state adopted)

K(1) Keedy, Mervin; Jameson, Richard; and Johnson, Patricia. Exploring Modern Mathematics, Book 1. New York: Holt, Rinehart and Winston, Inc., 1963.

K(2) Keedy, Mervin; Jameson, Richard; and Johnson, Patricia. Exploring Modern Mathematics, Book 2. New York: Holt, Rinehart and Winston, Inc., 1963.

Mc(7) McSwain, E. T.; Brown, K. W.; Gundlach, B. H.; and Cook,R. J. Mathematics 7. River Forest, Illinois: Laidlaw Brothers, 1965.

Mc(8) McSwain, E. T.; Brown, K.W.; Gundlach, B. H.,; and Cook, R. J. Mathematics 8. River Forest, Illinois: Laidlaw Brothers, 1965.

N-PA Nichols, Eugene D. Pre-Algebra Mathematics. New York: Holt, Rinehart and Winston, Inc., 1965.

* SMS(1) Suppes, Patrick; Meserve, Bruce; Sears, Phyllis. Sets, Numbers and Systems 1. Brandon, Miss.: The L. W. Singer Company, Inc., 1969.

* SMS(2) Suppes, Patrick; Meserve, Bruce; Sears, Phyllis. Sets, Numbers and Systems 2. Brandon, Miss.: The L. W. Singer Company, Inc., 1969.

PERFORMANCE OBJECTIVES

The student will

1. Define the set of integers using both the rule and roster method.
2. Perform the four operations with integers.
3. Simplify expressions involving integers, absolute value, and the four operations.

COURSE OUTLINE

I. Integers

- A. Explaination of need for structure
- B. Concept
  1. Extend the number line
  2. Introduce additive inverses (opposites)
  3. Define the set of integers
  4. Define absolute value
- C. Operations
  1. Addition
     - a. Definition
     - b. Skill practice
  2. Subtraction
     - a. Definition
     - b. Skill practice
  3. Multiplication
     - a. Definition
     - b. Skill practice
  4. Division
     - a. Definition
     - b. Skill practice

REFERENCES

K(2) (pp. 6-33, 187-188) Develops addition and subtraction with number line but multiplication depends on exponents to develop concept.

Mc(8) (pp. 46-57) Shows examples of pattern, then states the rule.

N-PA (pp. 224-268) Incorporates the study of properties while practicing skills. Develops concepts on the number line.

References - continued

SMS(1) (pp. 82-104) Introduces addition and subtraction on number line, multiplication by a table to show pattern. Studies properties also.

SMS(2) (pp. 37-54) Reviews thoroughly and introduces absolute value.

SUGGESTED STRATEGIES

1. Understanding of the extended number line can be helped by using examples such as the sea level scale and the thermometer.

2. Absolute value can be developed by showing addition and subtraction on the number line.

3. Students can discover the rules for multiplication themselves by doing selected examples.

4. Division should be shown to be the inverse of multiplication.

PERFORMANCE OBJECTIVES

The student will

1. Name a given set by roster.
2. Name a given set by rule.
3. Give examples of finite, infinite, equal, equivalent, and disjoint sets.
4. Determine whether one set is a subset of another set.
5. Find the union and intersection of sets.
6. Sketch a Venn Diagram to illustrate the following: $A \cup B$, $A \cap B$, $A \subseteq B$, $A \cap B = \emptyset$, $\overline{A}$.
7. State the relationship, in set notation, that is illustrated by a given Venn diagram.

COURSE OUTLINE

II. Sets

- A. Definition
- B. Notation
- C. Relations
  1. Equal
  2. Equivalent
  3. Subset
  4. Disjoint
- D. Types of Sets
  1. Finite
  2. Infinite
  3. Empty
- E. Operations
  1. Union
  2. Intersection
  3. Complement
- F. Venn Diagrams

REFERENCES

K(1) (pp. 180-185) Includes set theory complete with Venn diagrams. Omits finite, infinite.

Mc(8) (pp. 67-69) Omits practice with Venn diagrams.

N-PA (pp. 76-84, 207-216, 439) Uses set notation throughout the entire book with no distinct section on Venn diagrams.

SMS (1) (pp. 1-16, 302-312) Includes everything from outline except complements, best coverage.

SMS(2) (pp. 53-68) Reviews then extends to complements, good.

SUGGESTED STRATEGIES

1. The student should already know how to define integers by rule and roster method. Now put a name to the method and extend it to all sets.

2. Under notation, discuss: meaning of set, defining a set, naming a set, belonging to a set, and meaning of universal set. As a minimum, the following symbols should be included: $\emptyset$, $\in$, $\subset$, $\subseteq$, $\notin$, $\{x\}$, $\cup$, and $\cap$.

3. For some reason, students confuse the use of $\in$ and $\subset$; stress that $\in$ is used between an element and a set containing the element, and $\subset$ is used between two sets.

4. The strict use of capital block letters for designating sets and lower case letters for elements of sets should help to make the distinction between sets and elements clearer to the student.

5. Students should be made aware of the difference between a relation and an operation: an operation on two sets produces another set while a relation between two sets is simply a statement about those two sets.

6. Venn diagrams should be used to illustrate the algebraic definitions of operations and relations.

7. The student should realize $\emptyset \neq \{\emptyset\} \neq \{0\} \neq 0$.

PERFORMANCE OBJECTIVES

The student will:

1. Identify a number as being prime or composite.
2. Use the rules of divisibility for 2,3,4,5,6,8,9, 10,25 to test the divisibility of natural numbers.
3. Find the prime factorization for given natural numbers.
4. Find the greatest common factor for any two natural numbers.
5. Determine the least common multiple of any two natural numbers.
6. Simplify fractions.
7. Write a given fraction in higher terms.
8. Order a given set of fractions.
9. Perform the four operations with fractions.
10. Perform the four operations with decimals.
11. Write decimals in their equivalent fractional form.
12. Write fractions in their equivalent decimal form.
13. Identify the properties of number system from examples.
14. Write illustrations of the properties.

COURSE OUTLINE

III. Review of Non-negative Rational Number

- A. Prime Numbers
  - 1. Definition
  - 2. Sieve of Eratosthene
- B. Composite Numbers
- C. Prime Factorization
  - 1. Divisibility
  - 2. Factorization
  - 3. Prime factorization
- D. Greatest Common Factor (GCF)
  - 1. Define GCF
  - 2. Find GCF of two or more natural numbers
- E. Multiples and Least Common Multiple (LCM)
  - 1. Define multiples
  - 2. Find multiples of natural numbers
  - 3. Define LCM
  - 4. Find LCM of two or more natural numbers
- F. Fractions
  - 1. Equivalent fractions
  - 2. Ordering fractions
  - 3. Four operations

G. Decimals

1. Four operations

2. Conversion

   a. Decimals to fractions
   b. Fractions to decimals

H. Properties

1. Closure

2. Commutative

3. Associative

4. Distributive

5. Inverse

6. Identity

REFERENCES

K(1) (pp. 135-180, 231-278) Uses discovery for divisibility rules and uses prime factorization to find LCM and GCF.

Mc(7) (pp. 79-141) Moves from primes into divisibility and through GCF, LCM, fractions, and decimals.

Mc(8) (pp. 99-113) Reviews factorization, divisibility, GCF and LCM.

N-Pa (pp. 67-75, 85-89, 94-114, 126-151) Uses the intersection of sets for LCM and GCF.

SMS(1) (pp. 36-37, 46-61, 105-109) Assumes the student already knows these concepts and treats them as review.

SMS(2) (pp. 69-76) Reviews primes, LCM, and GCF.

SUGGESTED STRATEGIES

This entire section should be treated as review. If individual students show weaknesses it is suggested that they be referred to independent study for strengthening.

1. The Sieve of Eratosthenes can be used to exhibit primes while reinforcing the understanding of multiples.

2. Stress the unique prime factorization of natural numbers.

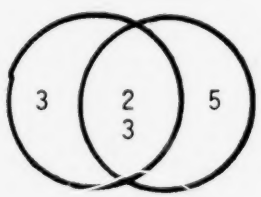
3. Point out the special status of the natural number 1; i.e., "one" is neither prime nor composite.

4. Relate (3.) to unique factorization as follows:

   If 1 were a prime, then $1^{3} \cdot 2 = 1^{2} \cdot 2 = 1 \cdot 2$ and there would not be a unique prime factorization of 2.

5. Use Venn diagrams to find GCF and LCM as follows:

$18 = 2 \cdot 3^{2}$ $\qquad\qquad$ $30 = 2 \cdot 3 \cdot 5$



union $3 \cdot 3 \cdot 2 \cdot 5$ = LCM

intersection $2 \cdot 3$ = GCF

PERFORMANCE OBJECTIVES

The student will:

1. Differentiate between number phrases and number sentences.
2. Differentiate between equations and inequalities.
3. Identify open sentences.
4. Find the solution sets of simple open sentences by inspection.

COURSE OUTLINE

IV. Mathematical Sentences

- A. Phrases
- B. Sentences
  1. Equations
  2. Inequalities
  3. Open sentences
  4. Solution sets

REFERENCES

K(1) (pp. 50-55) Introduces variables and equations.

K(2) (pp. 31-40) Covers equivalent phrases and simplifying phrases as well as equations and inequalities.

Mc(7) (pp. 41-44) Solves equations by inspection before going into formal solution.

Mc(8) (pp. 61-65) Reviews introduction to equations, inequalities and replacement sets.

SMS(1) (pp. 319) Assumes familiarity with the concepts.

SUGGESTED STRATEGIES

The main purpose of this section is to familiarize the students with the vocabulary, thus preparing them for the following section on graphing.

PERFORMANCE OBJECTIVES

The student will:

1. Graph the solution set of an equation or inequality on a number line, using the integers as the replacement set.
2. Graph points on a coordinate plane.
3. Write the coordinates of a given point as an ordered pair.
4. Graph simple linear equations.

COURSE OUTLINE

V. Graphing

- A. Number line
  - 1. Equations
  - 2. Inequalities
- B. Coordinate plane
  - 1. The coordinate plane
  - 2. Plotting points
  - 3. Graphing simple linear equations

REFERENCES

K(2) (pp. 45-53) Introduces graphs on a plane well, but practice is too difficult for a first attempt.

N-PA (pp. 412-420, 430-464) Includes topics from number lines to parabolas.

SMS(1) (pp. 186-216) Omits section on graphing on a number line but includes excellent section for graphing on a plane.

SMS(2) (pp. 34, 195-221) Uses graphing as first method of solving pairs of equations with little graphing on a number line.

SUGGESTED STRATEGIES

1. The student should understand the importance of domain when graphing on the number line.
2. To increase motivation, give the students series of ordered pairs to plot that form a picture when joined in sequence.
3. Have the student make a table for an equality when graphing an inequality, then choose the side that satisfies the inequality.

PRETEST

1. Express each fraction in simplest form.

   a. $\frac{28}{64}$ b. $\frac{13}{169}$

2. Express each mixed number as a fraction.

   a. $2\frac{1}{7}$ b. $7\frac{1}{12}$

3. Express each fraction as a decimal.

   a. $\frac{21}{8}$ b. $\frac{5}{7}$

4. Express each fraction as a mixed number.

   a. $\frac{15}{12}$ b. $\frac{29}{3}$

5. Express each fraction as a fraction with a denominator of 72.

   a. $\frac{5}{9}$ b. $\frac{41}{36}$

6. Express each decimal as a fraction in simplest form.

   a. .0175 b. .66

7. Write the prime factorization of each of the numbers.

   a. 294 b. 1400

8. Find the LCM of 6, 27, 12.

9. Find the GCF of 6, 27, 12.

10. Add.

a. $\frac{7}{8} + \frac{1}{3}$ b. $8\frac{1}{2} + 2\frac{4}{5}$

11. Subtract.

a. $7 - 3\frac{5}{8}$ b. $9\frac{1}{4} - 2\frac{2}{3}$

12. Multiply.

a. $\frac{5}{12} \times \frac{16}{20}$ b. $2\frac{1}{4} \times 2\frac{2}{3}$

13. Divide.

a. $4\frac{1}{2} \div 9$ b. $3\frac{5}{6} \div 2\frac{2}{3}$

14. Add.

a. .461 + .03 + 2.6 b. 4.6 + 9 + 15.057

15. Subtract.

a. 20.023 - .429 b. 62.3 - 1.48

16. Multiply.

a. 1.08 x .31 b. .647 x .0042

17. Divide.

a. 6.27 ÷ 1.1 b. .0156 ÷ .15

18. Arrange the fractions from smallest to largest: $\frac{2}{3}, \frac{7}{9}, \frac{11}{15}$.

19. Arrange the decimals from smallest to largest: .026, .03, .0164.

20. Simplify: $\dfrac{\frac{1}{2} + \frac{2}{3}}{\frac{3}{4} - \frac{1}{5}}$

PRETEST ANSWER KEY

1. a. $\frac{7}{16}$ b. $\frac{1}{13}$

2. a. $\frac{15}{7}$ b. $\frac{85}{12}$

3. a. 2.625 b. $.\overline{714285}$

4. a. $1\frac{1}{4}$ b. $9\frac{2}{3}$

5. a. $\frac{40}{72}$ b. $\frac{82}{72}$

6. a. $\frac{7}{400}$ b. $\frac{33}{50}$

7. a. $2 \cdot 3 \cdot 7^2$ b. $2^3 \cdot 5^2 \cdot 7$

8. 108

9. 3

10. a. $1\frac{5}{24}$ b. $11\frac{3}{10}$

11. a. $3\frac{3}{8}$ b. $6\frac{7}{12}$

12. a. $\frac{1}{3}$ b. 6

13. a. $\frac{1}{2}$ b. $\frac{23}{16}$ or $1\frac{7}{16}$

14. a. 3.091 b. 28.657

15. a. 19.594 b. 60.82

16. a. .3348 b. .0027174

17. a. 5.7 b. .104

18. $\frac{2}{3}, \frac{11}{15}, \frac{7}{9}$

19. .0164, .026, .03

20. $2\frac{4}{33}$

SAMPLE POSTTEST ITEMS

1.

1. a. Define the set of integers by roster.
   b. Define the set of integers by rule.

2. Perform the indicated operations:

   a. $-7 + 15 =$
   b. $9 - 25 =$
   c. $14 \div (-2) =$
   d. $(-16) \cdot (-3) =$
   e. $-3 \cdot 15 =$
   f. $-21 \div (-7) =$
   g. $-4 - 12 =$
   h. $8 - (-5) =$

3. Simplify

   a. $|-3|$
   b. $|3 - 4|$
   c. $-|4 - (-2)|$
   d. $|-4 + 7| - |-9 - 2|$

II.

1. Use set notation to specify the following sets.

   a. The two digit numbers less than 100

   b. The integers between -5 and 0

   c. The odd numbers greater than 2 but less than 9

2. Describe, in words, the following set.

   $\{x: x \in N \text{ and } 2 < x \text{ and } x < 10\}$

3. Use natural numbers to give examples of:

   a. a finite set

   b. equivalent sets

   c. an infinite set

   d. disjoint sets

   e. equal sets

4. State whether the following are true or false.

   a. $\{0, 3\} \subset \{0, 1, 2, 3, 4\}$

   b. $\{5, 7, 9\} \subset \{7\}$

   c. $\emptyset \subset \{0\}$

   d. $\{1, 3, 5,\} \subset \{1, 2, 4, 5, 6\}$

5. Given these sets: $A = \{0, 2, 4, 6, 8\}$, $B = \{1, 2, 3, 10\}$.

   a. What is the union of A and B?

   b. What is the intersection of A and B?

   Given these sets: $A = \{\text{the multiples of 3 between 6 and 18}\}$, $B = \{\text{the multiples of 4 greater than 5}\}$.

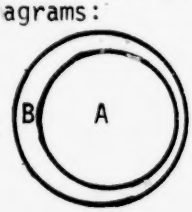
   c. What is the intersection of A and B?

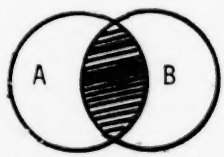
   d. What is the union of A and B?

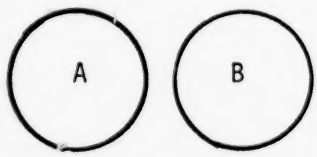
6. If A = {Tim, Tony, Fred, Mike} and B = {Al, Fred, Jim, Bob}, use Venn diagrams to determine:

   a. $A \cap B$ b. $A \cup B$ c. $\overline{B}$

7. State the relationship, in set notation, for these Venn diagrams:

   a. 

   b. 

   c. 

III. 1. Circle each prime number and draw a triangle around each composite number:

   1 2 3 6 8 11 17 18 21 87 93

2. Using the rules of divisibility, circle every number on the right which is a divisor of the given natural number.

   a. 372 2 3 4 5 6 8 9 10 25

   b. 3670 2 3 4 5 6 8 9 10 25

   c. 495 2 3 4 5 6 8 9 10 25

   d. 843 2 3 4 5 6 8 9 10 25

3. Give the prime factorization for each:

   a. 108 b. 1540

4. Find the greatest common factor for each pair:

   a. 48; 120 b. 105; 150

5. Determine the least common multiple for each pair:

   a. 15; 25 b. 36; 48

6. Simplify

   a. $\frac{4}{12}$ b. $\frac{39}{91}$

7. Write the fractions as equivalent fractions with denominator 60.

   a. $\frac{2}{3}$ b. $\frac{4}{15}$

8. Arrange the following fractions from smallest to largest:

   $\frac{4}{5}, \frac{13}{14}, \frac{22}{27}$

9. Perform the indicated operations:

   a. $\frac{2}{5} + 3\frac{1}{7}$ c. $2\frac{2}{5} \cdot \frac{4}{9}$

   b. $5\frac{1}{8} - 1\frac{2}{3}$ d. $8\frac{2}{3} \div 4\frac{1}{2}$

10. Perform the following operations as indicated:

    a. 0.05×14.8 c. $18.7 - 9.286$

    b. $257.1 + 16.25 + 8.007$ d. $0.0006 \div 0.04$

11. Express as a common fraction in simplest form:

    a. 0.06 c. 0.008

    b. 0.15 d. 0.625

12. Express as a decimal:

    a. $\frac{3}{4}$ b. $\frac{7}{8}$ c. $\frac{5}{12}$

13. Which property of the non-negative rationals is being illustrated?

    a. $\frac{2}{3} \cdot \frac{5}{5} = \frac{2}{3}$ c. $\frac{4}{7} \cdot \frac{7}{4} = 1$

    b. $\frac{1}{2}\left(\frac{3}{4} + 7\right) = \frac{1}{2} \cdot \frac{3}{4} + \frac{1}{2} \cdot 7$ d. $.4 + 3 + 3 + .4$

14. Give an illustration of each of the following properties:

a. The associative property of multiplication

b. The identity of addition

c. The distributive property of multiplication over addition

IV.

1. List the letters of the expressions that are number phrases.

a. $6 + x = 7$ c. $\frac{7}{0}$ d. $4 \div x$

b. $x + 4$

2. List the letters of the expressions that are inequalities.

a. $6 < x$ c. $12 - x \neq 14$

b. $7 + 6 = 19$ d. $a + 9 \geq 14$

3. List the letters of the expressions that are open sentences.

a. $6 + 10 = a$ c. $\frac{15}{3} - \frac{7}{8} = 2$

b. $x^2 - 5x = 0$ d. $2x - 3 < 4$

4. Find the solution set of each open sentence. Use the integers as the replacement set.

a. $x + 3 = 9$ c. $4x < 19$

b. $7 - b = 11$ d. $y - 3 \geq 4$

V.

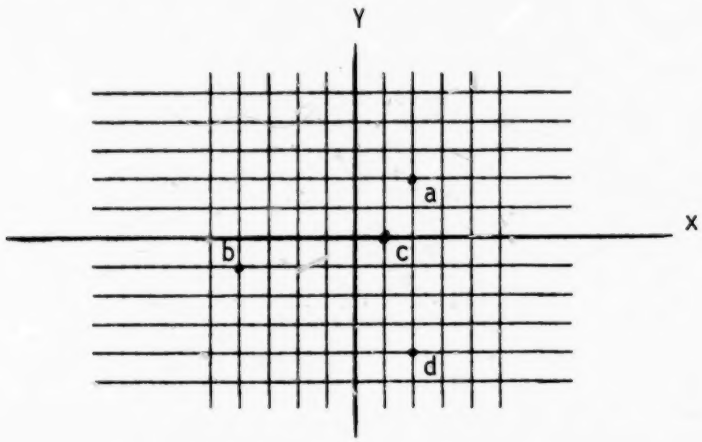
1. Use a number line to graph the solution sets for the following open sentences. Use the integers as the replacement set.

a. $3x = 12$ b. $5b - 7 > 4$ c. $m + 8 < 2$

2. Locate the following ordered pairs on a coordinate plane.

a. (2, 6) b. (-3, -4) c. (-4, 5) d. (5, -2)

3. Write the coordinates of the points shown on the graph.



4. Graph the following equations.

   a. $2x + y = 1$

   b. $2x + 3y = 6$

POSTTEST ANSWER KEY

1. a. $\{..., -2, -1, 0, 1, 2, 3, ...\}$

   b. The integers consist of zero, the natural numbers and the additive inverse for each natural number.

2. a. 8 c. -7 e. -45 g. -16

   b. -16 d. 48 f. 3 h. 13

3. a. 3 b. 1 c. -6 d. -8

II.

1. a. $\{10, 11, 12, ..., 97, 98, 99\}$ c. $\{3,5,7\}$

   b. $\{-4, -3, -2, -1\}$

2. The natural numbers between 2 and 10

3. Answers will vary

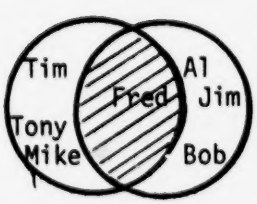
4. a. T c. T

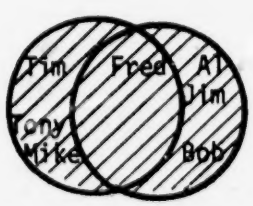
   b. F d. F

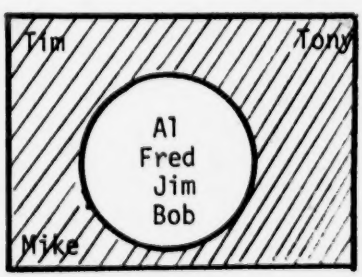
5. a. $\{0, 1, 2, 3, ...10\}$ c. $\{12\}$

   b. $\{2, 4, 6, 8\}$ d. $\{9, 15, 8, 12, 16, 20...\}$

6. a. b. c.







7. a. $A \subset B$ b. $A \cap B$ c. $A \cap B = \emptyset$

III.

1. 1 (2) (3) 6 8 (11) (17) 18 21 87 93

2. a. (2) (3) (4) 5 (6) 8 9 10 25
   b. (2) 3 4 (5) 6 8 9 (10) 25
   c. 2 (3) 4 (5) 6 8 (9) 10 25
   d. 2 (3) 4 5 6 8 9 10 25

3. a. $2^2 \cdot 3^3$ b. $2^2 \cdot 5 \cdot 7 \cdot 11$

4. a. 24 b. 15

5. a. 75 b. 144

6. a. $\frac{1}{3}$ b. $\frac{3}{7}$

7. a. $\frac{40}{60}$ b. $\frac{16}{60}$

8. $\frac{4}{5}, \frac{22}{27}, \frac{13}{14}$

9. a. $3\frac{19}{35}$ b. $3\frac{11}{24}$ c. $\frac{16}{15}$ d. $\frac{52}{27}$

10. a. .74 b. 281.357 c. 9.414 d. .015

11. a. $\frac{3}{50}$ b. $\frac{3}{20}$ c. $\frac{1}{125}$ d. $\frac{5}{8}$

12. a. .75 b. .875 c. $.41\overline{6}$

13. a. Identity, multiplication
    b. Distributive
    c. Inverse, multiplication
    d. Commutative, addition

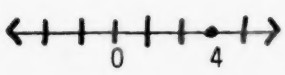
14. Answers will vary.

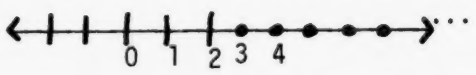
IV.

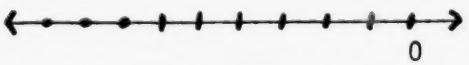
1. b.
2. a, c, d
3. a, b, d
4. a. $\{6\}$ b. $\{-4\}$ c. $\{\ldots, -1, 0, 1, 2, 3, 4\}$

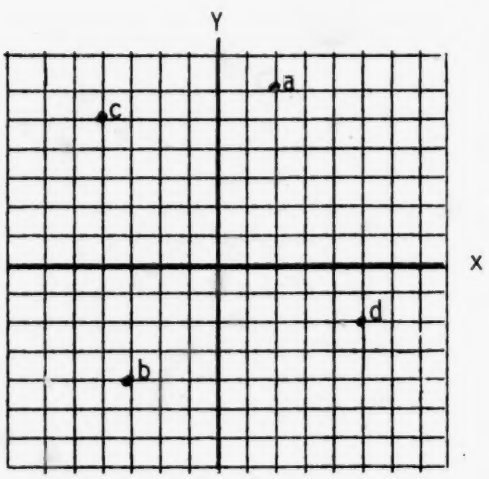
   d. $\{7, 8, 9, 10, \ldots\}$

V.

1. a. 

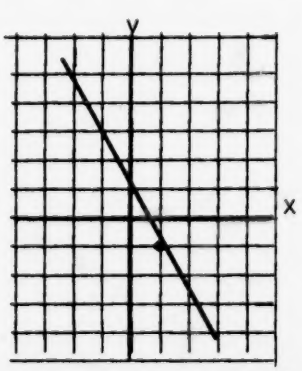
   b. 

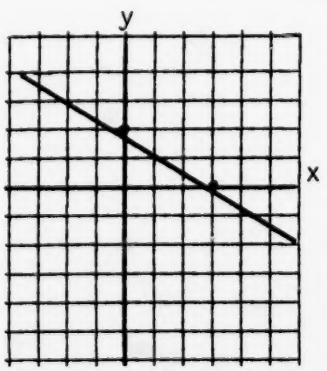
   c. 

2. 

3. a. (2, 2) b. (-4, -1) c. (1, 0) d. (2, -4)

4.

a. 

b. 

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